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ARC DIGITAL RASTER IMAGERY EVALUATION

Synectics Corporation

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The ARC Digital Raster Imagery (ADRI) evaluation process was an evaluation of the absolute horizontal and vertical accuracy of the ADRI product. Both absolute and relative horizontal evaluation activities employed the same statistical measures for the analysis, namely; the mean error in latitude and longitude; standard deviations of the errors in latitude and longitude; the root mean square of the errors for latitude and longitude; and the average error for latitude and longitude. The vertical accuracy analysis employed mean height error; standard deviation of the height errors; RMS of the height errors and average height error.

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SECTION 1. INTRODUCTION

This document is the Final Technical Report (FTR) for the ARC Digital Raster Imagery (ADRI) Evaluation Task.

1.1 IDENTIFICATION

This task is the ARC Digital Raster Imagery Evaluation task. The ADRI Evaluation task is task #5 under the IRR Task Ordering Agreement (TOA), Contract Number F30602-91-D-0003/0005, for Rome Laboratory, Griffiss Air Force Base, New York. The work on this task was done by Synectics Corporation as the prime contractor, and by TRIFID Corporation as a subcontractor. The Laboratory Program Manager (LPM) for this task is Mr. James A. Sieffert, RL/IRRP.

1.2 ADRI EVALUATION OBJECTIVES

The objectives for the ADRI Evaluation task were to provide an evaluation of government-furnished ADRI geocells to determine attainable point positioning accuracies, and to provide a processing capability to generate the ADRI product from SPOT 1A, LANDSAT Thematic Mapper, Digital Point Positioning Data Base, National High Altitude Photography (NHAP), reconnaissance images, and digitized paper maps. The multiple source ADRI generation capability produces a set of ADRI products which will be referenced as the Variety Pack in this report.

1.3 SCOPE OF THE ADRI EVALUATION TASK

The scope of the ADRI Evaluation included the following technical requirements:

√ Provide an evaluation of 15 government-furnished geocells of ADRI data.

- Determine the point position accuracies defined by horizontal Circular Error (CE) radius at a 90% confidence level, and vertical Linear Error (LE) at a 90% confidence level.
- Determine the CE and LE measures for Relative and Absolute point positioning.

- The evaluation sample will consist of at least four (4) mensurated points per geocell.

- Document the methods and results in the Final Technical Report.

√ Perform processing of government-provided SPOT 1A imagery utilizing Digital Terrain Elevation Data (DTED) and ground control geopositions to produce the ADRI product.

√ Perform processing of additional government-provided imagery to produce the ADRI product. The additional imagery included:

- Two LANDSAT Thematic Mapper scenes.
- Two digitized Point Positioning Data Base(PPDB) images.
- A single National High Altitude Photography (NHAP).
- Two reconnaissance images.
- A single digitized paper map.
- A single merged SPOT Pan/LANDSAT TM scene.

√ Deliver the software and data to the government.

1.4 DOCUMENT OVERVIEW

This document will include the report on the first task, which is the ADRI evaluation process. Section 3 of this volume presents the characteristics of the data, the interpretation of the statistics used in the analysis, and the methods employed for analysis. Section 4 presents the results of the analysis.

The ADRI processing capability and the Variety Pack generation will be presented in an unpublished document which will be retained as an internal document by Rome Laboratory/IRRP.

SECTION 2. REFERENCES

This section contains the following sections:

√ Government Documents
√ Non-government Documents

2.1 GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

√ Air Force Intelligence Support Agency Prototype Specification For ARC Digital Raster Imagery (ADRI), 3rd Draft Edition, August 1991

√ Defense Mapping Agency Product Specifications For Digital Landmass System (DLMS) Data Base, Second Edition, April 1983

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the contracting agency or as directed by the contracting officer.

2.2 NON-GOVERNMENT DOCUMENT

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the contracting agency or as directed by the contracting officer.

SECTION 3. ADRI EVALUATION METHODOLOGY

The purpose of this ADRI evaluation process is an initial comparison of the accuracies of point positioning data extracted from the ADRI product to control data extracted from high accuracy controlled imagery. This section presents a brief discussion of the ADRI product followed by a discussion of the statistics employed in analysis and their interpretation within this analysis. This section concludes with a discussion of the procedures used to conduct the data generation and analysis.

3.1 ADRI PRODUCT

The ARC Digital Raster Imagery (ADRI) product is designed to provide a general purpose data set of support data and computer readable digital images derived from various sources for Air Force weapon systems, and to serve as the imagery source for the Common Mapping, Charting,

Geopositioning, and Imagery Program (CMP). The ADRI is a standardized product which formats imagery data from various sources such as SPOT and LANDSAT into an image projected in the Equal Arc Second (ARC) raster system. The ARC system is specified in the Prototype Specification For ADRI, 3rd Draft Edition, August 1991.

The ADRI product has an accuracy requirement of ≤ 61 meters for horizontal absolute positioning and a relative (point to point) accuracy of ≤ 61 meters[2]. The goal of the ADRI product, comceptually, is to retain the horizontal accuracy equivalent to the ground sample distance (GSD) of the source imagery. ADRI imagery for this study was SPOT 10m panchromatic imagery, which has a GSD of 10 meters. The ADRI product does not include an explicit vertical accuracy requirement.

3.2 ADRI EVALUATION PROCESS

The ADRI evaluation process consisted of two activities. The first activity was an evaluation of the absolute horizontal and vertical accuracy of the product. The second activity was the evaluation of the relative horizontal and vertical accuracy of the product. Both absolute and relative horizontal evaluation activities employed the same statistical measures for the analysis. The statistical measures employed were the mean error in latitude and longitude, standard deviation (sigma) of the errors in latitude and longitude, the root mean square (RMS) of the errors for latitude and longitude, and the average error for latitude and longitude. The vertical accuracy analysis employed mean height error, standard deviation of the height errors, RMS of the height errors, and average height error.

All statistics were computed with the delta values or difference in latitude, longitude and/or height between a set of control points that were provided by the government and generated from high accuracy controlled imagery, and sets of measured locations of the same point using the ADRI product and the ADRI Evaluation software developed by TRIFID Corp. for Rome Laboratory under this task. A full description of the computation of the evaluation statistics is provided in Appendix A of the ADRI Assessment (ADRIX) Software User's Guide and Reference provided with the evaluation software.

3.2.1 HORIZONTAL ACCURACY ANALYSIS

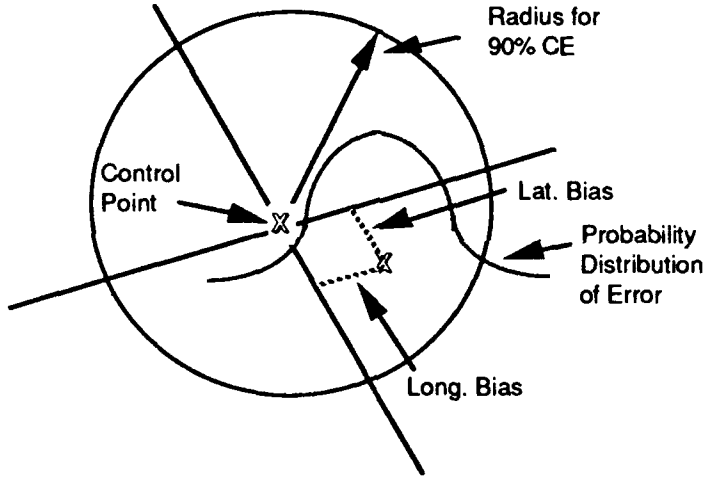
The processing of the horizontal accuracy begins with the computation of the straight line difference between the known control points and the measured points in both latitude and longitude. The statistical computations are then performed on these differences. The four statistics identified above are then computed for the absolute differences and an absolute 90% Circular Error (90% CE) is computed using the bias and standard deviation.

The mean latitude and longitude error represents the statistical mean of the latitude and longitude differences between the known and measured points. This value is the bias used in the computation of 90% CE. The bias can be thought of as the mean shift that has occurred for all of the measured points. Exhibit 3-1 is a graphic illustration of bias and 90% CE.

Given the characteristics of the ADRI production methodology and production experience to date, it is expected that a positional bias between the known and measured points would be within a two pixel limit or 20 meters.

The standard deviation is a measure of the distribution of the differences in the measured points. A small standard deviation (or sigma) is indicative of a narrow distribution range with most of the differences clustered near the mean difference. If the sigma for both latitude and longitude differences are the same value, the shape of the ellipse enclosing the points falling within the 90% CE would be round or circular, whereas, a significant difference between the latitude and longitude sigma would form an elliptical shape. The more elliptical the distribution of error, the more bias in one direction is indicated which could result from user sampling error, display biases, or a computation bias in the generation of the product.

Exhibit 3-1
Graphic Illustration of Statistical Bias and the Computation of 90% Circular Error



The RMS and average error statistics are statistics which give an indication of the magnitude of the differences. The RMS statistic is the mean of the differences squared, and the average difference is a straightforward average of the absolute value of the differences. The mean error statistic (bias) gives the sampling mean which could be very reasonable. For instance, a zero mean difference could result from data wherein half of the values are different negatively and the other half are different positively, in the same amount. All sample points could be different by ± 5 meters or ±50 meters and yield the same mean error. The RMS and average difference will reflect the magnitude of any sample difference. Both statistical measures should have comparable values, and any significant deviations between these two statistics will indicate a serious sampling error such as measuring the wrong point in the ADRI or using the wrong control points for analysis.

The relative horizontal accuracy analysis is a comparison of the differences between all possible point pairs in the measured points data set. A single delta distance statistic is computed

r all point pairs the are < 60 kilometers apart, and for a second "bin" of points that are ≥ 60 lometers apart. If there are not enough points in either bin, they are evaluated together as a single n. For each bin, 90% CE is computed. If there are less than 10 point pairs the sample is too ıall to be statistically significant and no relative accuracy statistics are computed.

The relative CE at 90% is computed by ranking the distance differences in order of agnitude on an ogive. The 90% CE value is determined by where 90% of the ranked point pairs lls.

2.2 VERTICAL ACCURACY ANALYSIS

The vertical accuracy analysis is performed in much the same manner as the horizontal ıalysis. The basic input to the statistical computations is the difference between the height of the ıeasured points and the control points. Since the source of the height in the measured data set is igital Terrain Elevation Data (DTED), this analysis is an evaluation of how well the ADRI and TED products in combination can be used to support point positioning. As stated previously, the DRI product does not have any explicit vertical accuracy requirements and does not include the TED.

The elevations for measured points are computed using the companion DTED data. The orizontal coordinates from the measured points data set are used to interpolate an elevation value hich is then evaluated against the control elevation that is provided as part of the control data set.

The statistical preparation used in the vertical accuracy analysis compute a mean height ifference which is the mean of all height differences of all points. This value represents an levation bias that may exist between the DTED and control data. The standard deviation is ɔmputed which is a measure of the distribution of the differences about the mean value. The MS and average absolute difference in height are also computed as measures of the magnitude to ıe average difference independent of the sign of the difference. A 90% Linear Error measure)0% LE) is computed using the bias and standard deviation to define the probability distribution ınction over which 90% is computed by integration of that function.

The relative vertical accuracy analysis examines all possible point pairs in the data set and ivides the point pairs into the same two 'bins' as in the horizontal accuracy analysis (two bins: 60 kilometers apart and ≥ 60 kilometers apart). If the total number of the point pairs is less than 0, then the analysis is not statistically significant and is not performed.

This vertical accuracy analysis is greatly dependent upon the accuracy of the DTED roduct. The DTED product has an absolute vertical accuracy requirement for Level I DTED of 30 meters. The derived elevations for this analysis use the known points (control) coordinates to ɔmpute the interpolated elevation which is then evaluated against the control heights provided by ıe government. Significant differences in vertical computations are, therefore, indicative of error ı the DTED product as opposed to the ADRI product. This analysis is a first step toward ;sessing the utility of the combination of these two products within the limitations of the DTED.

3.3 ADRI EVALUATION DATA SETS

For the ADRI Evaluation task, 15 government-furnished geocells of ADRI data and companion DTED data were provided. The 15 geocells mapped into regions over eastern UK and northern Germany. Exhibit 3-2 shows the location and ADRI data sources used. As illustrated, the ADRI data sources were four Distribution Rectangles (DR) on 8mm digital tapes. Simple logistics with data storage and retrieval software made it easiest to handle the test as four separate areas of interest (AOIs) which correspond to each DR. This enabled the loading of the data to proceed smoothly and eliminated the need to modify the transfer file information or change file names.

On a 1.6 gigabyte hard disk, four subdirectories were created, one for each ADRI DR. Within each subdirectory, one DTED subdirectory was created for the corresponding DR. The names of the four test AOIs were:

- √ /adri/tape7 — three geocells in the UK (#s 11,15 & 16 of the DR)
- √ /adri/tape9 — three geocells in northern Germany (#s 1, 6 & 11 of the DR)
- √ /adri/tape10 — three geocells in northern Germany (#s 7, 13 & 16 of the DR)
- √ /adri/tape11 — six geocells in northern Germany (#s 4, 6, 9, 14, 17 & 20 of the DR)

3.3.1 CONTROL POINT GENERATION

Once the four AOIs were loaded on the Synectics SUN IPC system, the ADRI evaluation software was employed to assist in the identification of control points for the analysis. In conjunction with government-provided high accuracy controlled imagery, the program LPM, Mr. James Sieffert and the Synectics analyst, Mr. Michael Wasilenko, viewed each AOI and randomly selected areas over which high accuracy controlled imagery was available. All control point locations were defined to be the center of the intersections of roads which were clearly identifiable on both the ADRI and the high accuracy controlled imagery products. As a general rule, there were five control points taken from each geocell. Exhibits 3-3a through 3-3d show the distribution of the control points within each geocell.

There were some notable limitations in the generation of the control data sets. The most significant limitation occurred with the data from tape9 over northern Germany. In the process of loading the images, only the first geocell would successfully load. Geocells 6 and 11 would not load and examination of the problem indicated a defective 8mm tape. Consequently, the tape9 test data set was limited to one geocell. Subsequently, a valid copy of the tape9 DR was received and could be viewed with the ADRI software. Unfortunately, it was made available too late to identify

Exhibit 3-2
Location of 15 Geocells Used for ADRI Evaluation

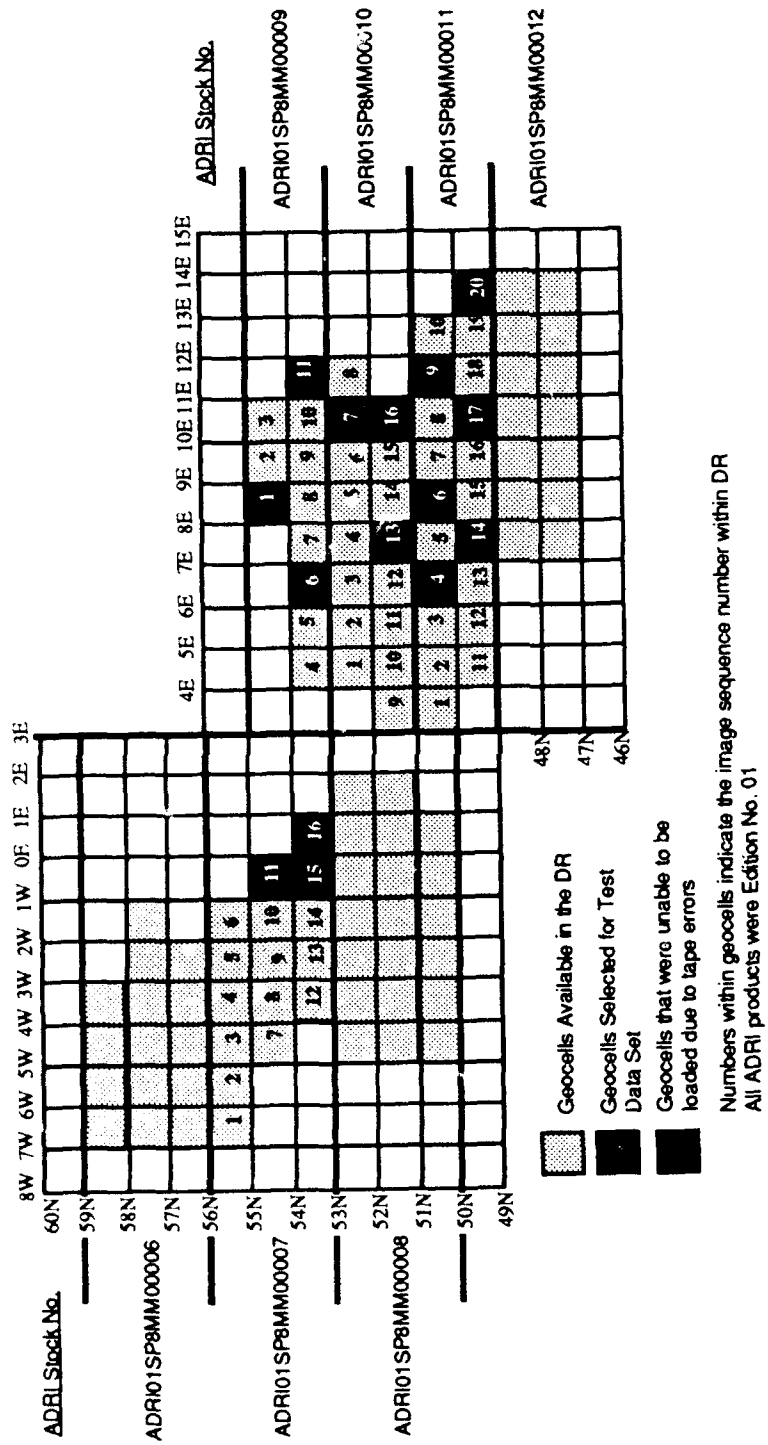


Exhibit 3-3a
Distribution of Control Points in the United Kingdom Area of Interest

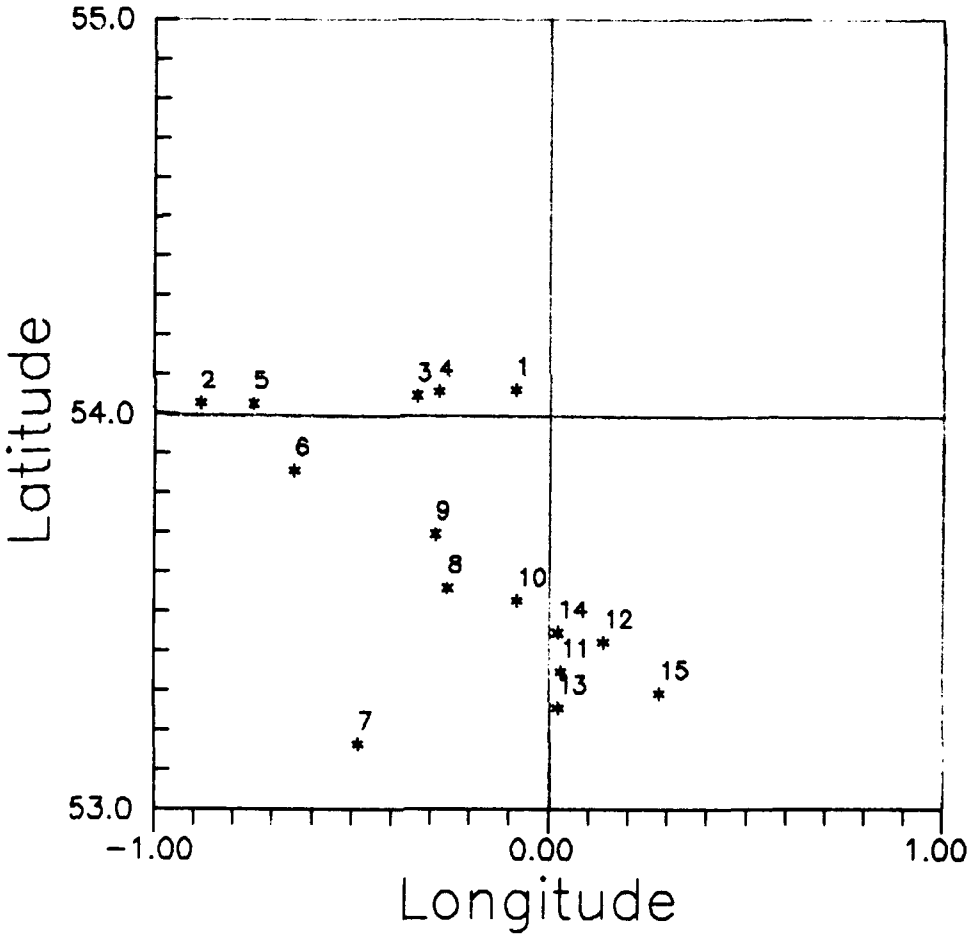


Exhibit 3-3b
Distribution of Control Points in the Germany #1 Area of Interest

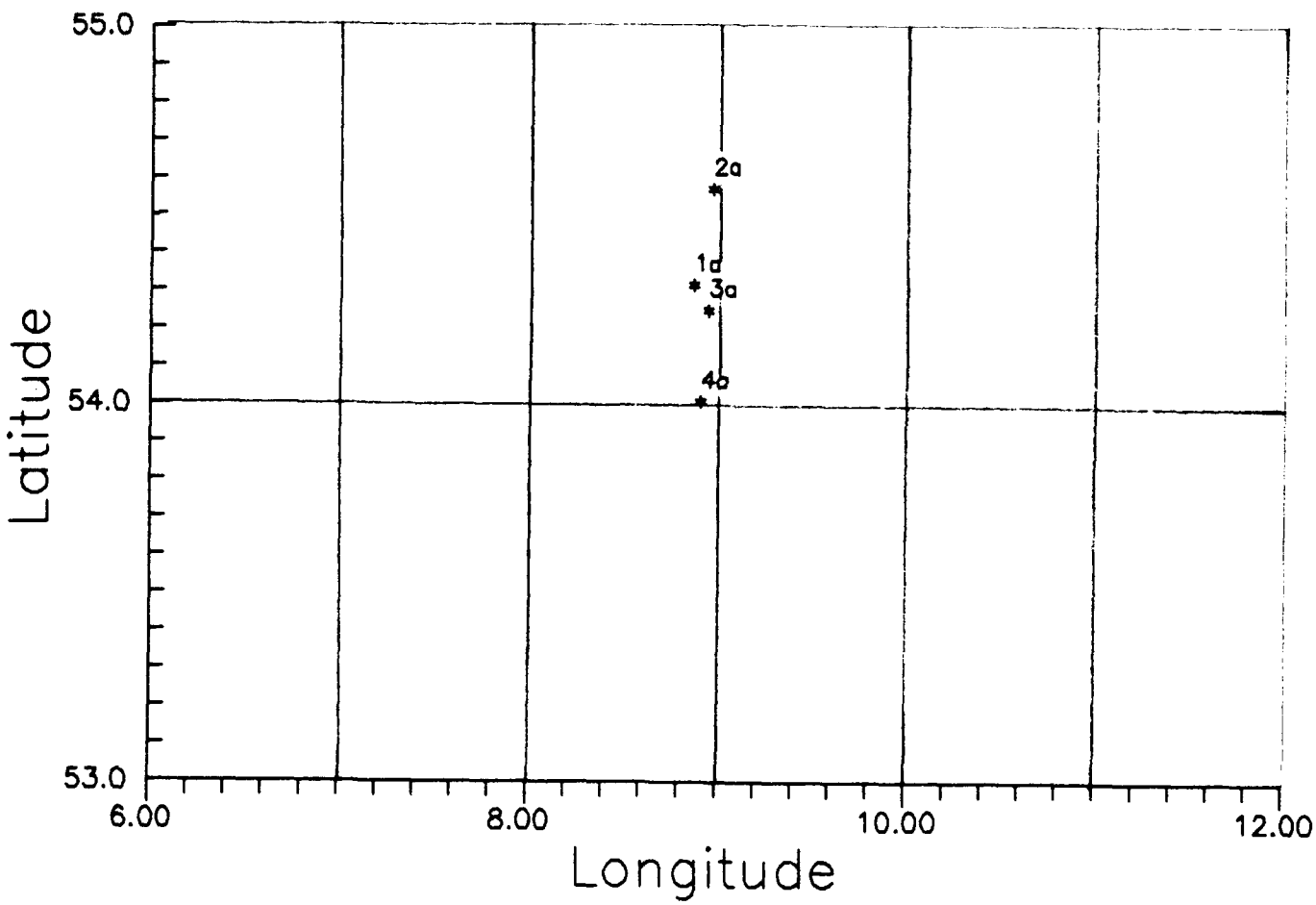


Exhibit 3-3c
Distribution of Control Points in the Germany #2 Area of Interest

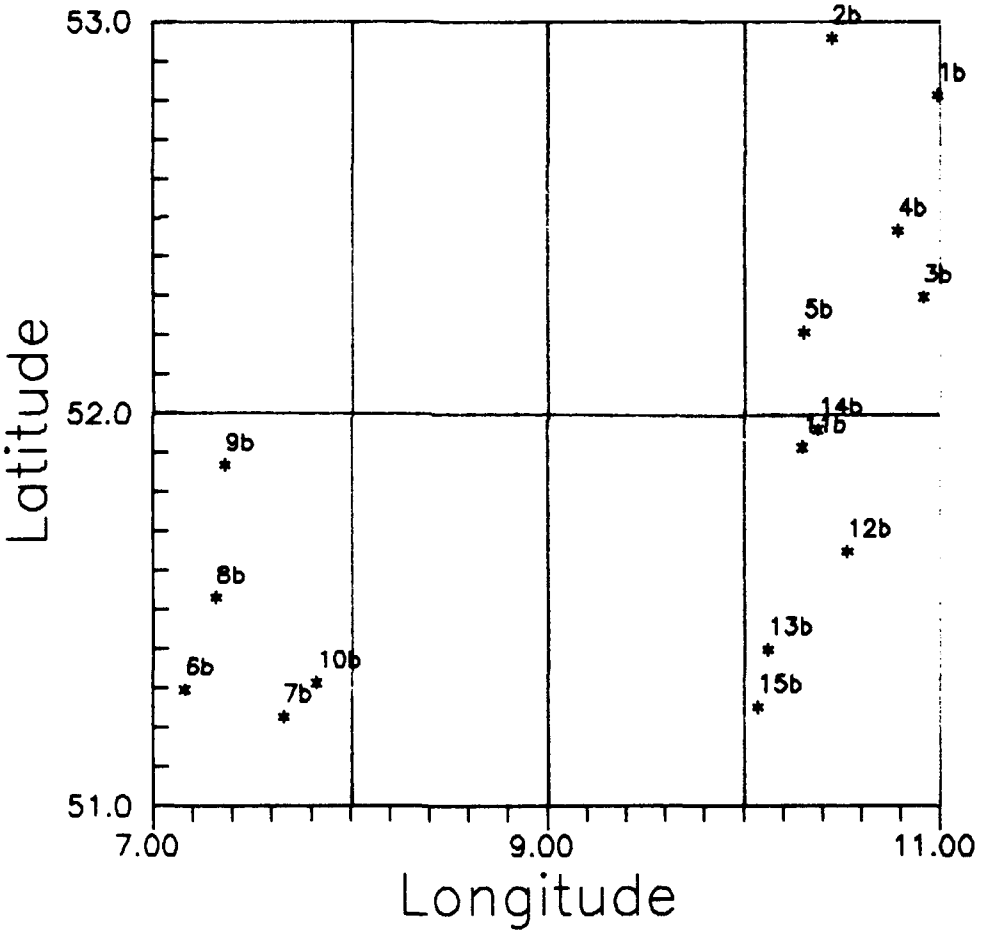
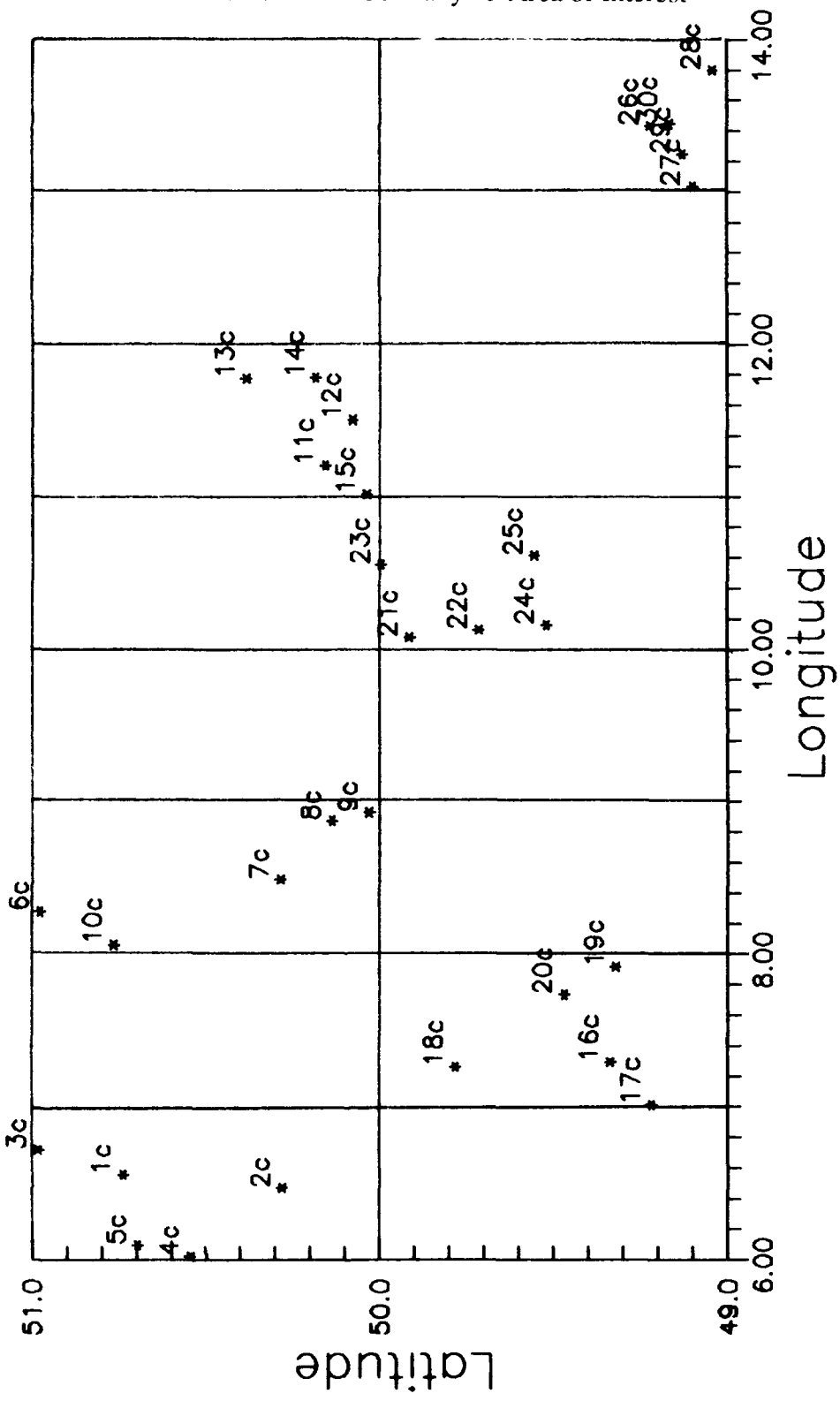


Exhibit 3-3d
Distribution of Control Points in the Germany #3 Area of Interest



the control. The absence of ADRI imagery also limited the number and distribution of control points over some areas. Both of these limitations combined to restrict the number of control points for the tape9 data set to just four points.

In total, there were 64 control points identified. These points were then extracted from the hardcopy high accuracy controlled imagery. These points are now defined as the test control and are assumed to be error free for purposes of analysis.

3.4 ADRI EVALUATION PROCEDURES

Once the control point data were received from the government, they were entered into the ADRI evaluation directory and saved as the control data sets. The control data were provided in digital and hard copy form as an Excel spreadsheet on a Macintosh. It was then possible, using a Macintosh connected to the SUN IPC via NCSA/BYU Telnet 2.3.1 communication software, to create the control data files directly on the SUN through a cut and paste process which eliminated the potential for any transcription errors that could occur if the data were manually typed into the system. Once the control data were validated on the SUN IPC, four subdirectories were created to contain the control data and all data collected and generated during analysis.

3.4.1 PRELIMINARY SYSTEM EVALUATION

As a validation step for the ADRI evaluation software and verification of the control data sets, a preliminary system evaluation was conducted using the control data points saved during the process of control point identification as the measured points, and the control data transferred from the Macintosh as the known points. This process surfaced some irregularities in the data and some environment problems with the ADRI software and test data.

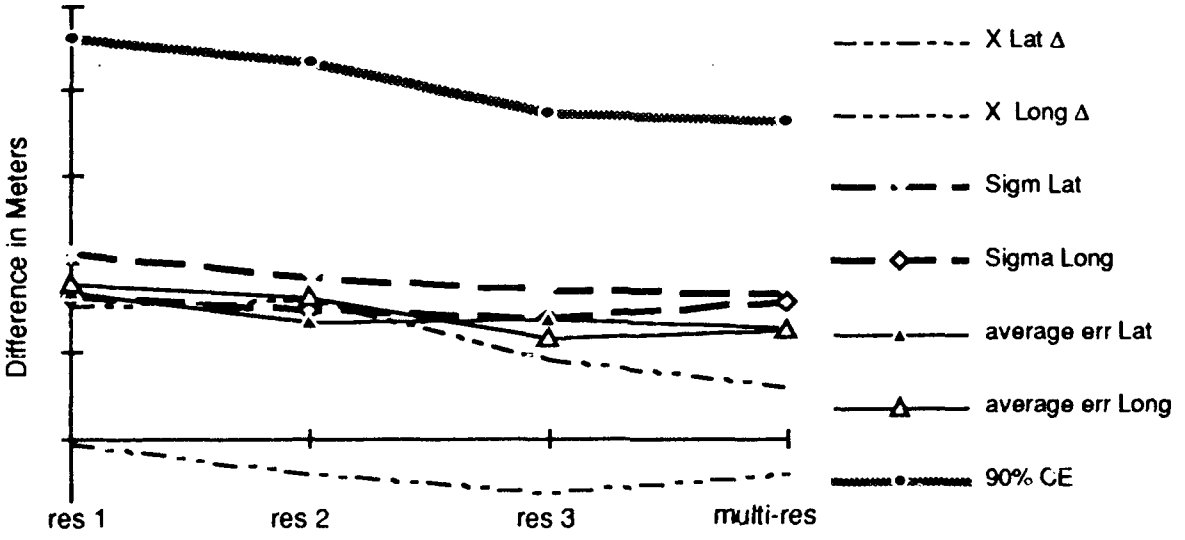
The first deviation surfaced in the horizontal accuracy analysis. In the AOI over the UK, and in two of the Germany AOIs, the statistics indicated a gross error in the data. Close examination showed that five control points were located at different road intersections than those located in the identification process. This was most likely caused by confusion over which point was being identified on the ADRI and on the hardcopy imagery. Fortunately, the points from the control data sets were also identifiable on the ADRI product and therefore used in the evaluation. A valuable result of this exercise was the validation of the statistics and their interpretation, since it was the analysis of these statistics which surfaced the data discrepancies. In other words, the statistical computations behaved as expected with corrupted inputs.

The second problem that surfaced involved the vertical analysis. The DTED for the test data sets were also provided on 1/4" tape as a single distribution rectangle with 15 geocells of data. The DTED cells were then loaded directly into the appropriate subdirectories for the AOIs. Attempts to execute the vertical accuracy analysis with the preliminary data sets failed. Examination of this problem, including consultation with TRIFID Corp., surfaced the need for the

DTED files to be numbered sequentially within each subdirectory. When loading the DTED cells for the DR, they were numbered DMADT000 to DMADT014, and the names were not changed. Through the simple process of renaming the files within each subdirectory, the vertical accuracy analysis was found to be working properly.

The third situation which the preliminary evaluation surfaced was the effect of user bias introduced during the sampling procedure. For the UK test data set, sample points were taken at the 1:1(no magnification), 1:2 (1x magnification) and 1:4 (2x magnification) resolutions and a fourth set was taken with a sample point at each of the three resolutions. The results of this analysis showed that the quality of sampling was best at the 1:4 resolution. This was not surprising since at that scale, a feature is still identifiable and a specific pixel can be easily selected repeatedly. The results of this preliminary analysis are illustrated in Exhibit 3-4. As one looks at the behavior of the statistics for each sampling method, one can see that all measures are most accurate at the 1:4 resolution. The apparent precision of the multiple resolution sample can be explained as a side effect of familiarity of the sample points by the user. The results of this preliminary analysis indicated that the sample procedure for the final ADRI evaluation can be done by sampling points at 2x magnification, and each point need only be sampled once since the pixel selected can be easily repeated at that magnification.

Exhibit 3-4
Results of a Preliminary Analysis Evaluating Sampling Methods



3.4.2 FINAL ADRI EVALUATION PROCEDURE

The final ADRI evaluation procedure was the straightforward process of sampling each control point location for each AOI and then executing the statistical applications. The procedure specification is:

1) *Execute the ADRI evaluation software specifying* the appropriate AOI.

2) Use the ADJUST CONTRAST menu bar item as needed to make the ADRI image as easy to view as possible.

3) Under the FILE menu bar item select the SET DIRECTORY item and enter the subdirectory where the control data can be found, and where the measured data and statistical files will be saved.

4) Under the FILE menu bar item set the INPUT VISIT FILE to the control data points file. For this analysis the control file names were: UKtest.pt, ger1test.pt, ger2test.pt, and ger3test.pt.

5) Under the FILE menu bar item set the OUTPUT POINT FILE to the name of the file to receive the measured points. For this analysis the measure point file names were: UK3res.pt, ger13res.pt, ger23res.pt, and ger33res.pt.

6) Under the FILE menu bar item set the REPORT NAME to the name for the statistical files that contain the data for horizontal and vertical accuracy analysis. For this analysis the report file names were: UK3rpt, ger13rpt, ger23rpt, and ger33rpt.

7) Under the VISIT FILE POINT menu bar item select the first control point. The ADRI image will be redrawn with the control located in the center of the image and with a box around the location of the point in both the reference and 1:1 image. N.B. the user should note the proper intersection at this time because the reference box is not shown on the enlargement.

8) Select the MAGNIFY menu bar item to magnify the image to the 1:2 magnification.

9) Select the MAGNIFY menu bar item a second consecutive time to reach the 1:4 magnification. At this scale the road intersection should be discernible, but blocky in appearance. Also, there is no reference as to the location of the control point that could bias user point selection.

10) Place the graphic cursor at the best location indicating the center point of the road intersection and click the left mouse button. A pop up menu should appear offering to set the selected point to that location, or to move the center of the image to that location. Select the "move to that location" option. A box will be drawn around that point. CAUTION: Do not choose the recentering option since this will cause the image to be redrawn at the 1:1 scale and it would be necessary to start the procedure again.

11) Select the SAVE POINT menu bar item. This selection will offer to tag this point with the same ID as the control point. Choose that option or type in the same identification name as the control point. Entering a different identification name will invalidate the analysis.

12) Repeat the process from step 7 to begin the selection of the next point.

13) Once all the measured points have been sampled and saved select the appropriate analysis application under the ANALYZE menu bar item.

SECTION 4. ADRI EVALUATION RESULTS

The ADRI evaluation procedure presented in the previous section was conducted on each of the four test Areas of Interest (AOIs). The four test areas will be referred to in this section and in the data tables presented as: UK (United Kingdom), Germany #1, Germany #2, and Germany #3. The number of evaluation data points for absolute accuracy analysis and the number of point pairs in each "bin" (low bin < 60 km, high bin ≥ 60 km) for relative accuracy analysis are shown in Exhibit 4-1. As noted in the previous section, one of the test AOIs over northern Germany had difficulty loading all three geocells. That test AOI is the Germany #1 AOI and, as one can see, has only four test points.

Exhibit 4-1
ADRI Evaluation Test Data Set Characteristics

AOI	# Points	# Point Pairs	# Pairs < 60km	# Pairs ≥ 60km
UK	15	105	60	45
Germany #1	4	6	6	0
Germany #2	15	105	25	80
Germany #3	30	435	50	385
Total # for Analysis	64	651	141	510

4.1 HORIZONTAL ACCURACY ANALYSIS

The horizontal accuracy requirement for the ADRI product derived from SPOT 10m panchromatic imagery is ±61 meters. The ADRI product generation also requires the maintenance of the resolution of the source imagery which means that the test imagery for this evaluation also has a 10m resolution. With this resolution, one would expect selection precision to be within two pixels which translates to ±20m if points are distinctive and clearly defined. Consequently, the expected result of this analysis are that the process of point positioning with the ADRI product should fall within a two pixel range and should be sufficiently accurate to support all but the most demanding point positioning requirements.

Exhibit 4-2 is a compilation of the horizontal accuracy statistics for each of the four test AOIs. The data are statistically comparable for all test areas with the possible exception of the Germany #1 data set. The data for this test area clearly show the most deviation. For instance, the latitude and longitude mean differences of -13.32 and -15.72 meters, respectively, are substantially larger than the other data sets which have a maximum difference of 5.76 meters. However, it is important to note that this deviation falls within the range of two pixels which is not significant. The small size of the data set is the most reasonable explanation for the Germany #1 variations.

Exhibit 4-2
ADRI Evaluation, Horizontal Accuracy Analysis Statistics

AOI	X Δ Lat	X Δ Long	sigma Lat	sigma Long	RMS Lat	RMS Long	Av. Error Lat	Av. Error Long	90% CE	Rel CE <60km	Rel CE ≥60km
UK	-3.08	4.46	8.39	6.86	8.67	7.99	6.83	5.77	18.55	24.45	21.29
Germany #1	-13.32	-15.72	3.38	3.16	13.64	15.96	13.32	15.72	25.32	insufficient data	insufficient data
Germany #2	-3.10	1.90	7.06	7.05	7.49	7.07	5.96	5.48	16.20	12.07	17.52
Germany #3	-2.66	5.76	6.42	8.44	6.85	10.10	5.53	8.25	18.73	17.95	20.00
Mean of 64	-5.54	-0.90	6.31	6.38	9.16	10.28	7.91	8.81	19.70	N/A	N/A
Mean of 60	-2.95	4.04	7.29	7.45	7.67	8.39	6.11	6.50	17.83	18.16	19.60

The summary statistics at the bottom of the table show the overall values for each statistic by treating the 64 points as a single data set. The last row in the table shows the summary statistics with the four points from the statistically insignificant Germany #1 data set eliminated. The statistics do improve when looking at the 60 point sample, but it is important to note that all values are indicative of acceptable accuracies. As one can see, the accuracy of the ADRI product falls well within expected parameters and has accuracies which clearly fall within the two pixel limit for absolute accuracies. The bias, or latitude and longitude offset, in all but the Germany #1 area, is within the target pixel ranging from 1.90 to 5.76 meters, which is physically as accurate as the selection could be, given the resolution of the imagery.

The standard deviations (sigma values) all indicate an acceptable error distribution. The data indicates that the sampling procedure did not introduce any bias in either the latitudinal or longitudinal direction with a slightly larger latitudinal difference with the UK data set (sigma lat. = 8.39; sigma long = 6.86) and a slightly larger longitudinal difference in the Germany #3 data set (sigma lat. = 6.42; sigma long = 8.44). Both the Germany #1 and #2 data sets have equivalent latitudinal and longitudinal distribution of differences. The small size of the Germany #1 data set is the reason for the relatively large distance errors with a relatively small sigma which means a very steep distribution. With a data set this small, one large difference can influence the entire sample, which is what happened in this case.

The bias and standard deviation are the statistics used to compute the 90% Circular Error (CE). The 90% CE values for the data sets as presented in Exhibit 4-2, are the radii of a circle in meters about each control point that would encompass 90% of the measured points. For the three most significant data sets, the 90% CE falls within the two pixel limit and indicates acceptable

accuracies. The Germany #1 data set is greater than the 2 pixel limit but is too small a sample to be considered statistically significant.

The RMS and average error statistics measure the magnitude of the differences about the mean. In each case, the values are consistent with the analysis based on the mean and standard deviation. The RMS values are larger than the mean values which indicate that the distribution of differences are both positive and negative. This conclusion is also supported by the balanced standard deviation for latitude and longitude differences. The average error statistics further support the same analysis as the value of the absolute differences which show a balanced distribution as well as acceptable accuracies.

The relative horizontal accuracy analysis is limited to the 90% CE error for two data bins. The low data bin consists of all the point pairs that are < 60 km apart and the high bin consists of point pairs that are ≥ 60 km apart. This statistic gives a measure of the spatial distribution of error over the ADRI product. A consistently significant difference (i.e., 30 to 40 meters) between the 90% CE of the two data bins would indicate a systematic error being distributed throughout the product which would be greatest over longer distances.

The findings of this initial analysis show that there is no indication of any systematic errors over the area of coverage of the ADRI product. The 90% CE for the relative horizontal accuracies of both the low and high bins are statistically comparable and within acceptable accuracies. The 90% CE values range from 12.07 for the low bin in the Germany #2 data set to 24.45 in the low bin for the UK data set. The average 90% CE for all data pairs (except the 6 pairs for the Germany #1 data set) falls within the 2 pixel limit, which means that one can expect a consistent level accuracy for point positioning anywhere within an ADRI image. The Germany #1 data set had less than 10 data pairs and was therefore eliminated from the relative accuracy analysis as being too small to be statistically significant.

4.2 VERTICAL ACCURACY ANALYSIS

The vertical accuracy evaluation portion of this analysis is an examination of the utility of the Digital Terrain Elevation Data (DTED) Level I product in conjunction with the ADRI product. The results of this evaluation are indicative of the quality of the DTED Level I product and do not reflect on the ADRI product. Measured elevation values are interpolated from the DTED Level I data using the latitude and longitude values in the control data sets. Measure points from the ADRI product are not used in this analysis.

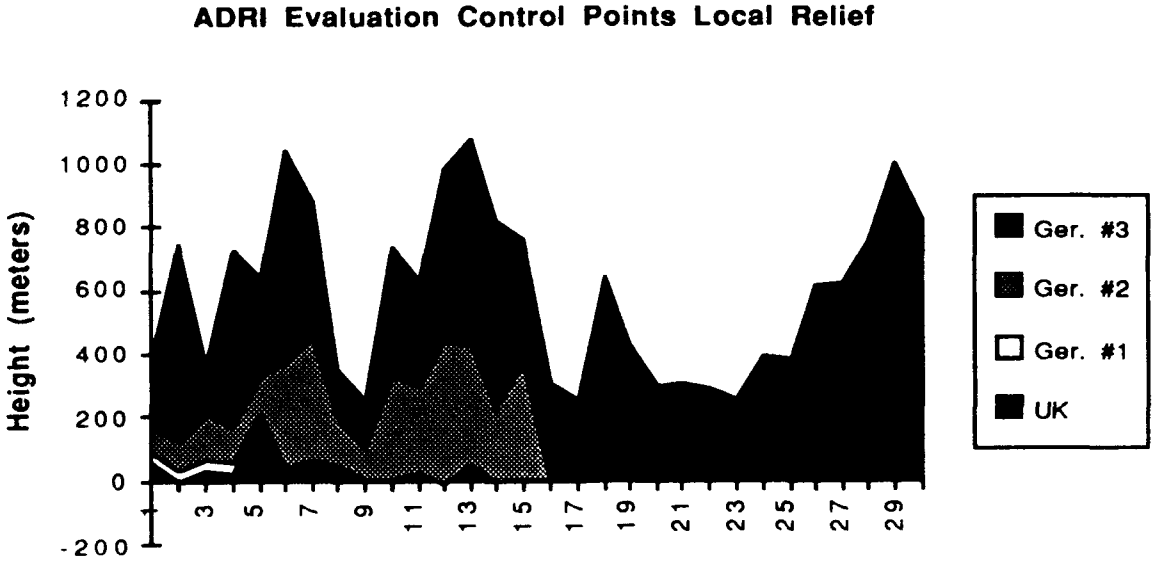
The expected results of this evaluation are that the elevation data will have at least the same accuracy levels as required for the product, which is ± 30 meters. The statistics for the absolute and relative accuracy analysis are presented in Exhibit 4-3. The same data sets and control points were used for the vertical accuracy analysis as were used for the horizontal accuracy analysis.

Exhibit 4-3
ADRI Evaluation, Vertical Accuracy Analysis Statistics

	Mean	Sigma	RMS	Average Err	90% LE	Low Bin 90% LE	High Bin 90% LE
U K	-1.47	14.48	14.06	11.39	23.94	32.49	39.66
Germany #1	-33.59	0.70	33.59	33.59	34.48		
Germany #2	-30.84	15.59	34.32	31.55	50.83	45.35	39.07
Germany #3	-44.06	18.97	47.84	44.06	68.37	31.15	45.58
Average	-27.49	12.44	32.45	30.15	44.41	36.33	41.44

As one can see in Exhibit 4-3, the accuracy level of the DTED Level I data falls short of the expected accuracy results. The UK data set did seem to perform the best with a mean elevation difference, standard deviation (sigma), RMS, average error and 90% LE within the ±30 meter requirement. The most likely explanation for the rather large values is the relative effect of local relief, illustrated in Exhibit 4-4, on the quality of the DTED and the interpolation process. The UK data set was over an area that has a relatively small local relief, which may have contributed to better performance of the data. The UK local relief is approximately 216 meters, but this is due almost entirely to control #5 which contributes to the majority of the relief. The data set over northern Germany has a local relief distribution as also shown in Exhibit 4-4. The four point data set for Germany #1 was insignificant for this analysis, while the other two Germany data sets show rather significant elevation variations, which is indicative of a much more variable terrain and would cause errors in the DTED product as well as in the interpolation of elevations from the product.

Exhibit 4-4
ADRI Evaluation, Control Local Relief Characteristics



The findings of this analysis are that the DTED Level I product is basically inadequate for all but the most general requirements for point positioning and is probably not the most advantageous companion for the ADRI.

4.3 SUMMARY

The findings of this initial analysis of the ADRI product are that, in terms of horizontal accuracy, the ADRI product performs well within its required limits for accuracy and can be expected to support horizontal point positioning requirements to within 20 meters of ground truth. The companion DTED data are, however, inadequate as an elevation data source with accuracies that can be expected to 2.5 to 3.5 times less accurate than the horizontal positioning.

This is an initial study, and a relatively small sample of points was used. Other factors such as variations in the display quality, user familiarity, cursor design, user interface, and image sources were held constant throughout this analysis and should be examined as a means of improving the point positioning process. The vertical accuracy problem requires more analysis with the possible use of Level II DTED which is at a comparable resolution with the ADRI product. Finally, more geographic areas should be examined so that a broad cross-section of terrain and cultural phenomena are part of the evaluation. This would support the broad applicability of the ADRI product.

APPENDIX A

STATISTICS SUMMARY, UK TAPE ADRI01SP8MM00007 HORIZONTAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE HORIZONTAL ACCURACY

POINT ID	DELTA LAT	DELTA LON
uk1	-5.14	17.42
uk2	-16.85	15.53
uk3	-9.73	9.26
uk4	-8.15	12.20
uk5	-8.14	2.89
uk6	3.13	1.28
uk7	1.58	2.14
uk8	-7.07	-6.71
uk9	20.32	0.32
uk10	-3.21	3.81
uk11	0.92	-0.30
uk12	-6.16	1.65
uk13	-7.38	-2.78
uk14	-2.49	9.65
uk15	2.15	0.58

TOTAL NUMBER OF POINTS = 15

90% CIRCULAR ERROR = 18.55

	LAT	LONG
MEAN	-3.08	4.46
SIGMA	8.39	6.86
RMS	8.67	7.99
AVERAGE ERROR	6.83	5.77

HORIZONTAL RELATIVE ACCURACY
TOTAL NUMBER OF POINT PAIR COMBINATIONS = 105

LOW BIN: ALL POINTS LESS THAN 60 KM APART

ID POINT COMBINATION	DELTA DISTANCE
uk1 uk2	10.53
uk1 uk3	7.88
uk1 uk4	5.14
uk1 uk5	10.53
uk1 uk6	15.10
uk1 uk9	30.35
uk2 uk3	5.69
uk2 uk4	2.45
uk2 uk5	12.70
uk2 uk6	24.45
uk2 uk9	36.45

uk3 uk4	3.27
uk3 uk5	6.28
uk3 uk6	3.70
uk3 uk8	4.18
uk3 uk9	30.68
uk4 uk5	9.31
uk4 uk6	0.39
uk4 uk8	1.61
uk4 uk9	28.32
uk5 uk6	11.15
uk5 uk9	23.56
uk6 uk8	3.19
uk6 uk9	11.16
uk6 uk10	6.21
uk7 uk8	11.09
uk7 uk10	3.05
uk7 uk11	2.44
uk7 uk12	4.81
uk7 uk13	7.32
uk7 uk14	2.77
uk7 uk15	1.36
uk8 uk9	26.19
uk8 uk10	8.98
uk8 uk11	2.13
uk8 uk12	6.81
uk8 uk13	2.19
uk8 uk14	11.03
uk8 uk15	0.21
uk9 uk10	21.03
uk9 uk11	16.70
uk9 uk12	20.25
uk9 uk13	24.35
uk9 uk14	23.80
uk9 uk15	13.98
uk10 uk11	5.30
uk10 uk12	0.16
uk10 uk13	2.63
uk10 uk14	2.97
uk10 uk15	6.12
uk11 uk12	4.05
uk11 uk13	8.43
uk11 uk14	3.90
uk11 uk15	0.40
uk12 uk13	2.83
uk12 uk14	6.32
uk12 uk15	7.51
uk13 uk14	4.90
uk13 uk15	5.58
uk14 uk15	9.71

RELATIVE CE 90% = 24.45

HIGH BIN: ALL POINTS GREATER THAN 60 KM APART

ID POINT COMBINATION	DELTA DISTANCE
uk1 uk7	10.03
uk1 uk8	11.98
uk1 uk10	10.22
uk1 uk11	15.23
uk1 uk12	9.78
uk1 uk13	8.81
uk1 uk14	7.04
uk1 uk15	16.46
uk2 uk7	21.29
uk2 uk8	21.32
uk2 uk10	17.85
uk2 uk11	23.62
uk2 uk12	17.21
uk2 uk13	18.05
uk2 uk14	14.48
uk2 uk15	23.90
uk3 uk7	10.55
uk3 uk10	7.79
uk3 uk11	12.99
uk3 uk12	6.36
uk3 uk13	5.35
uk3 uk14	6.73
uk3 uk15	14.45
uk4 uk7	8.30
uk4 uk10	6.64
uk4 uk11	11.89
uk4 uk12	5.66
uk4 uk13	3.97
uk4 uk14	6.17
uk4 uk15	14.04
uk5 uk7	9.70
uk5 uk8	5.92
uk5 uk10	3.29
uk5 uk11	9.24
uk5 uk12	2.27
uk5 uk13	3.46
uk5 uk14	0.30
uk5 uk15	9.34
uk6 uk7	1.66
uk6 uk11	0.74
uk6 uk12	6.58
uk6 uk13	6.56
uk6 uk14	9.77
uk6 uk15	0.18
uk7 uk9	17.91

RELATIVE CE 90% = 21.29

STATISTICS SUMMARY, UK TAPE ADRI01SP8MM00007 VERTICAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE VERTICAL ACCURACY

POINT ID	DELTA HEIGHT
uk1	20.26
uk2	24.51
uk3	-8.61
uk4	-14.24
uk5	-24.82
uk6	4.59
uk7	-19.40
uk8	-19.79
uk9	-1.12
uk10	6.50
uk11	0.22
uk12	12.70
uk13	-3.46
uk14	5.60
uk15	-4.98

NUMBER OF POINTS = 15

90% LINEAR ERROR =	23.94
MEAN	-1.47
SIGMA	14.48
RMS	14.06
AVERAGE ERROR	11.39

VERTICAL RELATIVE ACCURACY
TOTAL NUMBER OF POINT PAIR COMBINATIONS = 105

LOW BIN: ALL POINTS LESS THAN 60 KM APART

ID POINT COMBINATION	DELTA HEIGHT
uk1 uk2	4.25
uk1 uk3	28.87
uk1 uk4	34.50
uk1 uk5	45.08
uk1 uk6	15.68
uk1 uk9	21.38
uk2 uk3	33.12
uk2 uk4	38.75
uk2 uk5	49.33
uk2 uk6	19.93
uk2 uk9	25.63
uk3 uk4	5.63
uk3 uk5	16.21
uk3 uk6	13.19
uk3 uk8	11.18
uk3 uk9	7.49
uk4 uk5	10.58

uk4 uk6	18.83
uk4 uk8	5.55
uk4 uk9	13.12
uk5 uk6	29.40
uk5 uk9	23.70
uk6 uk8	24.38
uk6 uk9	5.71
uk6 uk10	1.91
uk7 uk8	0.39
uk7 uk10	25.90
uk7 uk11	19.62
uk7 uk12	32.10
uk7 uk13	15.94
uk7 uk14	25.00
uk7 uk15	14.41
uk8 uk9	18.67
uk8 uk10	26.29
uk8 uk11	20.01
uk8 uk12	32.49
uk8 uk13	16.33
uk8 uk14	25.39
uk8 uk15	14.80
uk9 uk10	7.62
uk9 uk11	1.34
uk9 uk12	13.82
uk9 uk13	2.34
uk9 uk14	6.72
uk9 uk15	3.86
uk10 uk11	6.28
uk10 uk12	6.20
uk10 uk13	9.96
uk10 uk14	0.90
uk10 uk15	11.48
uk11 uk12	12.48
uk11 uk13	3.68
uk11 uk14	5.38
uk11 uk15	5.20
uk12 uk13	16.16
uk12 uk14	7.10
uk12 uk15	17.68
uk13 uk14	9.06
uk13 uk15	1.53
uk14 uk15	10.58

RELATIVE LE 90% = 32.49

HIGH BIN: ALL POINTS GREATER THAN 60 KM APART

ID POINT COMBINATION	DELTA HEIGHT
uk1 uk7	39.66
uk1 uk8	40.05
uk1 uk10	13.76
uk1 uk11	20.05
uk1 uk12	7.56

uk1 uk13	23.72
uk1 uk14	14.66
uk1 uk15	25.25
uk2 uk7	43.91
uk2 uk8	44.30
uk2 uk10	18.01
uk2 uk11	24.30
uk2 uk12	11.81
uk2 uk13	27.97
uk2 uk14	18.91
uk2 uk15	29.50
uk3 uk7	10.79
uk3 uk10	15.11
uk3 uk11	8.82
uk3 uk12	21.31
uk3 uk13	5.15
uk3 uk14	14.21
uk3 uk15	3.62
uk4 uk7	5.16
uk4 uk10	20.74
uk4 uk11	14.46
uk4 uk12	26.94
uk4 uk13	10.78
uk4 uk14	19.84
uk4 uk15	9.25
uk5 uk7	5.42
uk5 uk8	5.03
uk5 uk10	31.32
uk5 uk11	25.03
uk5 uk12	37.52
uk5 uk13	21.36
uk5 uk14	30.42
uk5 uk15	19.83
uk6 uk7	23.99
uk6 uk11	4.37
uk6 uk12	8.11
uk6 uk13	8.05
uk6 uk14	1.01
uk6 uk15	9.57
uk7 uk9	18.28

RELATIVE LE 90% = 39.66

STATISTICS SUMMARY, TAPE ADRI01SP8MM00009 HORIZONTAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE HORIZONTAL ACCURACY

POINT ID	DELTA LAT	DELTA LON
ger3a	-15.94	-16.74
ger1a	-9.59	-13.96
ger2a	-16.42	-19.66
ger4a	-11.33	-12.53

TOTAL NUMBER OF POINTS = 4

90% CIRCULAR ERROR = 25.32

	LAT	LONG
MEAN	-13.32	-15.72
SIGMA	3.38	3.16
RMS	13.64	15.96
AVERAGE ERROR	13.32	15.72

HORIZONTAL RELATIVE ACCURACY
TOTAL NUMBER OF POINT PAIR COMBINATIONS = 6

ALL DATA IS GROUPED INTO A SINGLE BIN

ID POINT COMBINATION	DELTA DISTANCE
ger3a ger1a	3.62
ger3a ger2a	0.60
ger3a ger4a	4.97
ger1a ger2a	7.97
ger1a ger4a	1.86
ger2a ger4a	5.52

INSUFFICIENT DATA TO COMPUTE 90% CE

STATISTICS SUMMARY, TAPE ADRI01SP8MM00009 VERTICAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE VERTICAL ACCURACY

POINT ID	DELTA HEIGHT
ger1a	-32.85
ger2a	-33.90
ger3a	-34.40
ger4a	-33.20

NUMBER OF POINTS = 4

90% LINEAR ERROR =	34.48
MEAN	-33.59
SIGMA	0.70
RMS	33.59
AVERAGE ERROR	33.59

VERTICAL RELATIVE ACCURACY
TOTAL NUMBER OF POINT PAIR COMBINATIONS = 6

ALL DATA IS GROUPED INTO A SINGLE BIN

ID POINT COMBINATION	DELTA HEIGHT
ger1a ger2a	1.05
ger1a ger3a	1.55
ger1a ger4a	0.35
ger2a ger3a	0.50
ger2a ger4a	0.70
ger3a ger4a	1.20

INSUFFICIENT DATA TO COMPUTE 90% LE

STATISTICS SUMMARY, TAPE ADRI01SP8MM00010 HORIZONTAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE HORIZONTAL ACCURACY

POINT ID	DELTA LAT	DELTA LON
ger1b	-7.58	-2.13
ger2b	-4.20	-8.33
ger3b	-14.58	4.77
ger4b	-2.92	1.66
ger5b	-4.68	2.01
ger11b	-8.97	1.08
ger12b	-0.23	2.26
ger13b	-3.52	16.24
ger14b	-14.66	-5.32
ger15b	3.10	15.37
ger7b	-2.10	-4.52
ger6b	12.59	4.77
ger8b	-2.13	3.35
ger9b	5.72	3.86
ger10b	-2.41	-6.56

TOTAL NUMBER OF POINTS = 15

90% CIRCULAR ERROR = 16.20

	LAT	LONG
MEAN	-3.10	1.90
SIGMA	7.06	7.05
RMS	7.49	7.07
AVERAGE ERROR	5.96	5.48

HORIZONTAL RELATIVE ACCURACY
TOTAL NUMBER OF POINT PAIR COMBINATIONS = 105

LOW BIN: ALL POINTS LESS THAN 60 KM APART

ID POINT COMBINATION	DELTA DISTANCE
ger1b ger2b	7.12
ger1b ger3b	6.39
ger1b ger4b	5.64
ger2b ger4b	2.61
ger3b ger4b	11.90
ger3b ger5b	0.51
ger3b ger11b	1.32
ger3b ger14b	7.16
ger4b ger5b	0.92
ger5b ger11b	4.30
ger5b ger14b	8.57
ger11b ger12b	7.15
ger11b ger13b	8.41
ger11b ger14b	8.55
ger12b ger13b	7.53

ger12b ger14b	11.58
ger12b ger15b	10.26
ger13b ger15b	6.28
ger7b ger6b	5.98
ger7b ger8b	4.58
ger7b ger10b	1.78
ger6b ger8b	14.10
ger6b ger10b	12.07
ger8b ger9b	7.86
ger8b ger10b	7.98

RELATIVE CE 90% = 12.07

HIGH BIN: ALL POINTS GREATER THAN 60 KM APART

ID POINT COMBINATION	DELTA DISTANCE
ger1b ger5b	4.68
ger1b ger11b	0.05
ger1b ger12b	8.14
ger1b ger13b	9.97
ger1b ger14b	7.74
ger1b ger15b	15.72
ger1b ger7b	1.34
ger1b ger6b	16.34
ger1b ger8b	7.06
ger1b ger9b	10.34
ger1b ger10b	0.41
ger2b ger3b	14.63
ger2b ger5b	0.73
ger2b ger11b	3.93
ger2b ger12b	3.61
ger2b ger13b	3.70
ger2b ger14b	10.30
ger2b ger15b	10.33
ger2b ger7b	4.16
ger2b ger6b	20.53
ger2b ger8b	10.34
ger2b ger9b	15.30
ger2b ger10b	2.58
ger3b ger12b	12.58
ger3b ger13b	14.96
ger3b ger15b	20.32
ger3b ger7b	2.78
ger3b ger6b	10.03
ger3b ger8b	2.00
ger3b ger9b	2.28
ger3b ger10b	4.86
ger4b ger11b	5.62
ger4b ger12b	2.74
ger4b ger13b	4.46
ger4b ger14b	13.59
ger4b ger15b	10.16
ger4b ger7b	4.75
ger4b ger6b	9.75

ger4b ger8b	1.67
ger4b ger9b	4.30
ger4b ger10b	6.62
ger5b ger12b	4.26
ger5b ger13b	3.05
ger5b ger15b	9.62
ger5b ger7b	4.33
ger5b ger6b	9.58
ger5b ger8b	1.92
ger5b ger9b	3.52
ger5b ger10b	6.28
ger11b ger15b	14.73
ger11b ger7b	2.73
ger11b ger6b	9.62
ger11b ger8b	3.23
ger11b ger9b	2.78
ger11b ger10b	4.92
ger12b ger7b	7.00
ger12b ger6b	4.56
ger12b ger8b	0.95
ger12b ger9b	0.94
ger12b ger10b	9.03
ger13b ger14b	16.57
ger13b ger7b	20.58
ger13b ger6b	10.70
ger13b ger8b	13.09
ger13b ger9b	14.47
ger13b ger10b	22.80
ger14b ger15b	22.39
ger14b ger7b	5.31
ger14b ger6b	17.52
ger14b ger8b	10.59
ger14b ger9b	9.56
ger14b ger10b	3.11
ger15b ger7b	19.89
ger15b ger6b	10.70
ger15b ger8b	10.91
ger15b ger9b	11.56
ger15b ger10b	21.59
ger7b ger9b	5.18
ger6b ger9b	6.90
ger9b ger10b	2.48

RELATIVE CE 90% = 17.52

STATISTICS SUMMARY, TAPE ADRI01SP8MM00010 VERTICAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE VERTICAL ACCURACY

POINT ID	DELTA HEIGHT
ger1b	-35.40
ger2b	-41.83
ger3b	-33.75
ger4b	-34.70
ger5b	-27.44
ger6b	-66.75
ger7b	-14.09
ger8b	-37.75
ger9b	-33.40
ger10b	-22.00
ger11b	-20.05
ger12b	5.32
ger13b	-40.02
ger14b	-33.05
ger15b	-27.73

NUMBER OF POINTS = 15

90% LINEAR ERROR =	50.83
MEAN	-30.84
SIGMA	15.59
RMS	34.32
AVERAGE ERROR	31.55

VERTICAL RELATIVE ACCURACY
TOTAL NUMBER OF POINT PAIR COMBINATIONS = 105

LOW BIN: ALL POINTS LESS THAN 60 KM APART

ID POINT COMBINATION	DELTA HEIGHT
ger1b ger2b	6.43
ger1b ger3b	1.65
ger1b ger4b	0.70
ger2b ger4b	7.13
ger3b ger4b	0.95
ger3b ger5b	6.31
ger3b ger11b	13.70
ger3b ger14b	0.70
ger4b ger5b	7.26
ger5b ger11b	7.39
ger5b ger14b	5.61
ger6b ger7b	52.66
ger6b ger8b	29.00
ger6b ger10b	44.75
ger7b ger8b	23.67
ger7b ger10b	7.91
ger8b ger9b	4.35

ger8b ger10b	15.76
ger11b ger12b	25.37
ger11b ger13b	19.97
ger11b ger14b	13.00
ger12b ger13b	45.35
ger12b ger14b	38.37
ger12b ger15b	33.06
ger13b ger15b	12.29

RELATIVE LE 90% = 45.35

HIGH BIN: ALL POINTS GREATER THAN 60 KM APART

ID POINT COMBINATION	DELTA HEIGHT
ger1b ger5b	7.96
ger1b ger6b	31.35
ger1b ger7b	21.31
ger1b ger8b	2.35
ger1b ger9b	2.00
ger1b ger10b	13.40
ger1b ger11b	15.35
ger1b ger12b	40.72
ger1b ger13b	4.62
ger1b ger14b	2.35
ger1b ger15b	7.67
ger2b ger3b	8.08
ger2b ger5b	14.38
ger2b ger6b	24.93
ger2b ger7b	27.74
ger2b ger8b	4.07
ger2b ger9b	8.43
ger2b ger10b	19.83
ger2b ger11b	21.78
ger2b ger12b	47.15
ger2b ger13b	1.80
ger2b ger14b	8.78
ger2b ger15b	14.09
ger3b ger6b	33.00
ger3b ger7b	19.66
ger3b ger8b	4.00
ger3b ger9b	0.35
ger3b ger10b	11.75
ger3b ger12b	39.07
ger3b ger13b	6.27
ger3b ger15b	6.02
ger4b ger6b	32.05
ger4b ger7b	20.61
ger4b ger8b	3.06
ger4b ger9b	1.30
ger4b ger10b	12.70
ger4b ger11b	14.65
ger4b ger12b	40.02
ger4b ger13b	5.32
ger4b ger14b	1.65

ger4b ger15b	6.97
ger5b ger6b	39.31
ger5b ger7b	13.35
ger5b ger8b	10.31
ger5b ger9b	5.96
ger5b ger10b	5.44
ger5b ger12b	32.76
ger5b ger13b	12.58
ger5b ger15b	0.29
ger6b ger9b	33.35
ger6b ger11b	46.70
ger6b ger12b	72.07
ger6b ger13b	26.73
ger6b ger14b	33.70
ger6b ger15b	39.02
ger7b ger9b	19.31
ger7b ger11b	5.96
ger7b ger12b	19.41
ger7b ger13b	25.94
ger7b ger14b	18.96
ger7b ger15b	13.65
ger8b ger11b	17.71
ger8b ger12b	43.08
ger8b ger13b	2.27
ger8b ger14b	4.71
ger8b ger15b	10.02
ger9b ger10b	11.40
ger9b ger11b	13.35
ger9b ger12b	38.72
ger9b ger13b	6.62
ger9b ger14b	0.35
ger9b ger15b	5.67
ger10b ger11b	1.95
ger10b ger12b	27.32
ger10b ger13b	18.02
ger10b ger14b	11.05
ger10b ger15b	5.73
ger11b ger15b	7.68
ger13b ger14b	6.97
ger14b ger15b	5.32

RELATIVE LE 90% = 39.07

STATISTICS SUMMARY, TAPE ADRI01SP8MM00011 HORIZONTAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE HORIZONTAL ACCURACY

POINT ID	DELTA LAT	DELTA LON
ger1c	1.36	1.31
ger2c	0.20	-13.56
ger3c	-1.11	-1.51
ger4c	-12.21	11.50
ger5c	6.21	4.70
ger6c	-10.48	4.49
ger7c	-8.43	0.14
ger8c	12.80	12.30
ger9c	-5.81	8.79
ger10c	-4.66	15.00
ger11c	8.42	-2.60
ger12c	-3.66	6.42
ger13c	-3.87	9.01
ger14c	-1.16	8.34
ger15c	-6.95	9.11
ger16c	-7.24	-0.80
ger17c	-4.00	-8.15
ger18c	3.84	12.72
ger19c	-2.99	4.58
ger20c	-1.15	-1.89
ger21c	0.53	21.29
ger22c	-5.89	4.65
ger23c	-5.20	11.64
ger24c	-2.19	5.36
ger25c	9.73	5.02
ger26c	-7.08	1.69
ger27c	-1.28	14.03
ger28c	-7.01	-8.75
ger29c	-17.39	23.93
ger30c	-3.05	14.11

TOTAL NUMBER OF POINTS = 30

90% CIRCULAR ERROR = 18.73

	LAT	LONG
MEAN	-2.66	5.76
SIGMA	6.42	8.44
RMS	6.85	10.10
AVERAGE ERROR	5.53	8.25

HORIZONTAL RELATIVE ACCURACY
TOTAL NUMBER OF POINT PAIR COMBINATIONS = 435

LOW BIN: ALL POINTS LESS THAN 60 KM APART

ID POINT COMBINATION	DELTA DISTANCE
ger1c ger2c	2.91
ger1c ger3c	3.38
ger1c ger4c	2.12
ger1c ger5c	4.06
ger2c ger4c	26.92
ger2c ger5c	3.95
ger3c ger5c	9.29
ger4c ger5c	15.45
ger6c ger10c	10.57
ger7c ger8c	0.63
ger7c ger9c	4.61
ger8c ger9c	16.57
ger11c ger12c	12.86
ger11c ger13c	3.39
ger11c ger14c	10.10
ger11c ger15c	2.28
ger11c ger23c	8.52
ger12c ger13c	1.15
ger12c ger14c	2.96
ger12c ger15c	2.21
ger13c ger14c	2.72
ger14c ger15c	0.97
ger15c ger23c	2.69
ger16c ger17c	4.40
ger16c ger18c	10.42
ger16c ger19c	5.27
ger16c ger20c	1.58
ger17c ger20c	6.89
ger18c ger20c	6.66
ger19c ger20c	5.50
ger21c ger22c	3.70
ger21c ger23c	10.78
ger21c ger24c	0.55
ger21c ger25c	17.95
ger22c ger23c	5.48
ger22c ger24c	3.61
ger22c ger25c	6.69
ger23c ger24c	0.34
ger23c ger25c	15.45
ger24c ger25c	1.11
ger26c ger27c	13.57
ger26c ger28c	8.33
ger26c ger29c	11.22
ger26c ger30c	2.10
ger27c ger28c	21.95
ger27c ger29c	6.47
ger27c ger30c	0.33
ger28c ger29c	34.18
ger28c ger30c	18.24
ger29c ger30c	5.24

PELATIVE CE 90% = 17.95

HIGH BIN: ALL POINTS GREATER THAN 60 KM APART

ID POINT COMBINATION	DELTA DISTANCE
ger1c ger6c	0.59
ger1c ger7c	2.23
ger1c ger8c	5.67
ger1c ger9c	9.66
ger1c ger10c	13.51
ger1c ger11c	5.25
ger1c ger12c	5.84
ger1c ger13c	8.06
ger1c ger14c	7.19
ger1c ger15c	9.34
ger1c ger16c	7.50
ger1c ger17c	3.56
ger1c ger18c	2.47
ger1c ger19c	5.33
ger1c ger20c	0.56
ger1c ger21c	18.66
ger1c ger22c	5.88
ger1c ger23c	11.50
ger1c ger24c	5.06
ger1c ger25c	0.31
ger1c ger26c	2.97
ger1c ger27c	12.28
ger1c ger28c	6.38
ger1c ger29c	26.97
ger1c ger30c	13.00
ger2c ger3c	1.40
ger2c ger6c	10.06
ger2c ger7c	13.67
ger2c ger8c	24.53
ger2c ger9c	22.97
ger2c ger10c	23.88
ger2c ger11c	10.59
ger2c ger12c	20.16
ger2c ger13c	22.44
ger2c ger14c	21.91
ger2c ger15c	23.12
ger2c ger16c	12.73
ger2c ger17c	5.74
ger2c ger18c	16.08
ger2c ger19c	14.83
ger2c ger20c	9.23
ger2c ger21c	34.19
ger2c ger22c	19.06
ger2c ger23c	25.56
ger2c ger24c	18.66
ger2c ger25c	15.31
ger2c ger26c	16.47
ger2c ger27c	26.62
ger2c ger28c	6.69
ger2c ger29c	40.22
ger2c ger30c	27.31

ger3c ger4c	1.36
ger3c ger6c	6.08
ger3c ger7c	5.28
ger3c ger8c	4.27
ger3c ger9c	11.05
ger3c ger10c	16.83
ger3c ger11c	3.59
ger3c ger12c	8.28
ger3c ger13c	10.81
ger3c ger14c	9.50
ger3c ger15c	11.84
ger3c ger16c	6.14
ger3c ger17c	2.22
ger3c ger18c	0.94
ger3c ger19c	4.19
ger3c ger20c	0.08
ger3c ger21c	19.25
ger3c ger22c	7.69
ger3c ger23c	13.56
ger3c ger24c	6.22
ger3c ger25c	0.16
ger3c ger26c	5.28
ger3c ger27c	13.72
ger3c ger28c	3.88
ger3c ger29c	29.16
ger3c ger30c	14.75
ger4c ger6c	5.83
ger4c ger7c	11.42
ger4c ger8c	4.33
ger4c ger9c	3.95
ger4c ger10c	5.11
ger4c ger11c	15.56
ger4c ger12c	5.34
ger4c ger13c	1.97
ger4c ger14c	3.34
ger4c ger15c	2.47
ger4c ger16c	10.86
ger4c ger17c	15.69
ger4c ger18c	10.27
ger4c ger19c	11.28
ger4c ger20c	17.06
ger4c ger21c	6.88
ger4c ger22c	7.88
ger4c ger23c	0.56
ger4c ger24c	8.81
ger4c ger25c	12.56
ger4c ger26c	9.75
ger4c ger27c	0.25
ger4c ger28c	19.44
ger4c ger29c	13.88
ger4c ger30c	0.69
ger5c ger6c	3.66
ger5c ger7c	0.80
ger5c ger8c	4.91

ger5c ger9c	7.66
ger5c ger10c	9.55
ger5c ger11c	7.97
ger5c ger12c	2.91
ger5c ger13c	4.62
ger5c ger14c	4.09
ger5c ger15c	6.53
ger5c ger16c	9.03
ger5c ger17c	4.86
ger5c ger18c	6.67
ger5c ger19c	6.78
ger5c ger20c	1.30
ger5c ger21c	16.88
ger5c ger22c	3.88
ger5c ger23c	8.94
ger5c ger24c	3.62
ger5c ger25c	1.44
ger5c ger26c	0.56
ger5c ger27c	10.34
ger5c ger28c	8.81
ger5c ger29c	24.56
ger5c ger30c	10.81
ger6c ger7c	2.85
ger6c ger8c	18.08
ger6c ger9c	2.60
ger6c ger11c	13.72
ger6c ger12c	0.67
ger6c ger13c	3.03
ger6c ger14c	0.83
ger6c ger15c	2.56
ger6c ger16c	1.11
ger6c ger17c	0.70
ger6c ger18c	16.30
ger6c ger19c	7.41
ger6c ger20c	7.67
ger6c ger21c	4.61
ger6c ger22c	3.16
ger6c ger23c	3.02
ger6c ger24c	5.80
ger6c ger25c	13.50
ger6c ger26c	3.50
ger6c ger27c	3.31
ger6c ger28c	12.25
ger6c ger29c	20.09
ger6c ger30c	5.00
ger7c ger10c	4.25
ger7c ger11c	3.70
ger7c ger12c	6.03
ger7c ger13c	9.47
ger7c ger14c	8.19
ger7c ger15c	8.88
ger7c ger16c	0.25
ger7c ger17c	2.20
ger7c ger18c	16.96

ger7c ger19c	6.61
ger7c ger20c	5.17
ger7c ger21c	16.79
ger7c ger22c	2.86
ger7c ger23c	10.69
ger7c ger24c	0.69
ger7c ger25c	4.16
ger7c ger26c	1.53
ger7c ger27c	10.31
ger7c ger28c	8.06
ger7c ger29c	25.41
ger7c ger30c	11.59
ger8c ger10c	15.34
ger8c ger11c	15.36
ger8c ger12c	5.77
ger8c ger13c	5.88
ger8c ger14c	4.80
ger8c ger15c	2.11
ger8c ger16c	22.45
ger8c ger17c	26.08
ger8c ger18c	2.32
ger8c ger19c	17.20
ger8c ger20c	19.72
ger8c ger21c	11.74
ger8c ger22c	1.67
ger8c ger23c	1.37
ger8c ger24c	3.16
ger8c ger25c	5.38
ger8c ger26c	4.97
ger8c ger27c	5.75
ger8c ger28c	14.00
ger8c ger29c	20.00
ger8c ger30c	5.69
ger9c ger10c	2.95
ger9c ger11c	9.97
ger9c ger12c	2.11
ger9c ger13c	0.86
ger9c ger14c	0.19
ger9c ger15c	0.48
ger9c ger16c	8.89
ger9c ger17c	13.17
ger9c ger18c	5.79
ger9c ger19c	0.89
ger9c ger20c	5.96
ger9c ger21c	11.40
ger9c ger22c	3.74
ger9c ger23c	2.95
ger9c ger24c	4.81
ger9c ger25c	9.61
ger9c ger26c	6.19
ger9c ger27c	3.50
ger9c ger28c	15.84
ger9c ger29c	17.91
ger9c ger30c	4.41

ger10c ger11c	20.44
ger10c ger12c	8.38
ger10c ger13c	5.88
ger10c ger14c	7.19
ger10c ger15c	4.61
ger10c ger16c	7.56
ger10c ger17c	8.48
ger10c ger18c	6.34
ger10c ger19c	0.98
ger10c ger20c	0.78
ger10c ger21c	2.17
ger10c ger22c	7.28
ger10c ger23c	2.81
ger10c ger24c	8.75
ger10c ger25c	16.58
ger10c ger26c	10.88
ger10c ger27c	2.56
ger10c ger28c	19.84
ger10c ger29c	13.25
ger10c ger30c	1.59
ger11c ger16c	2.69
ger11c ger17c	8.72
ger11c ger18c	14.84
ger11c ger19c	2.78
ger11c ger20c	1.72
ger11c ger21c	20.21
ger11c ger22c	1.48
ger11c ger24c	1.45
ger11c ger25c	5.20
ger11c ger26c	11.83
ger11c ger27c	18.48
ger11c ger28c	3.41
ger11c ger29c	36.23
ger11c ger30c	19.83
ger12c ger16c	8.09
ger12c ger17c	14.16
ger12c ger18c	6.78
ger12c ger19c	1.78
ger12c ger20c	7.59
ger12c ger21c	15.23
ger12c ger22c	2.58
ger12c ger23c	4.91
ger12c ger24c	0.20
ger12c ger25c	7.89
ger12c ger26c	1.89
ger12c ger27c	3.58
ger12c ger28c	10.25
ger12c ger29c	21.95
ger12c ger30c	5.72
ger13c ger15c	1.79
ger13c ger16c	10.56
ger13c ger17c	16.12
ger13c ger18c	4.81
ger13c ger19c	4.00

ger13c	ger20c	9.53
ger13c	ger21c	12.73
ger13c	ger22c	4.91
ger13c	ger23c	1.62
ger13c	ger24c	1.86
ger13c	ger25c	7.32
ger13c	ger26c	2.52
ger13c	ger27c	0.31
ger13c	ger28c	9.81
ger13c	ger29c	19.44
ger13c	ger30c	2.56
ger14c	ger16c	10.53
ger14c	ger17c	16.50
ger14c	ger18c	4.84
ger14c	ger19c	4.31
ger14c	ger20c	9.91
ger14c	ger21c	12.83
ger14c	ger22c	5.36
ger14c	ger23c	2.21
ger14c	ger24c	3.16
ger14c	ger25c	4.38
ger14c	ger26c	0.94
ger14c	ger27c	3.33
ger14c	ger28c	8.77
ger14c	ger29c	22.17
ger14c	ger30c	5.28
ger15c	ger16c	9.91
ger15c	ger17c	15.78
ger15c	ger18c	4.28
ger15c	ger19c	3.28
ger15c	ger20c	9.41
ger15c	ger21c	13.28
ger15c	ger22c	3.48
ger15c	ger24c	0.41
ger15c	ger25c	12.70
ger15c	ger26c	6.34
ger15c	ger27c	0.62
ger15c	ger28c	15.22
ger15c	ger29c	17.91
ger15c	ger30c	2.45
ger16c	ger21c	23.89
ger16c	ger22c	5.91
ger16c	ger23c	12.94
ger16c	ger24c	6.91
ger16c	ger25c	7.81
ger16c	ger26c	3.06
ger16c	ger27c	14.91
ger16c	ger28c	7.25
ger16c	ger29c	25.72
ger16c	ger30c	15.25
ger17c	ger18c	13.34
ger17c	ger19c	12.77
ger17c	ger21c	29.75
ger17c	ger22c	12.19

ger17c ger23c	18.75
ger17c ger24c	13.83
ger17c ger25c	15.19
ger17c ger26c	10.19
ger17c ger27c	22.38
ger17c ger28c	0.06
ger17c ger29c	32.66
ger17c ger30c	22.56
ger18c ger19c	0.55
ger18c ger21c	8.23
ger18c ger22c	7.86
ger18c ger23c	2.06
ger18c ger24c	6.62
ger18c ger25c	8.47
ger18c ger26c	9.75
ger18c ger27c	1.75
ger18c ger28c	19.47
ger18c ger29c	14.00
ger18c ger30c	1.94
ger19c ger21c	17.09
ger19c ger22c	0.56
ger19c ger23c	6.03
ger19c ger24c	0.98
ger19c ger25c	2.23
ger19c ger26c	2.56
ger19c ger27c	9.47
ger19c ger28c	12.69
ger19c ger29c	20.25
ger19c ger30c	9.72
ger20c ger21c	22.95
ger20c ger22c	5.78
ger20c ger23c	12.06
ger20c ger24c	7.23
ger20c ger25c	7.45
ger20c ger26c	4.06
ger20c ger27c	15.81
ger20c ger28c	6.03
ger20c ger29c	27.19
ger20c ger30c	16.09
ger21c ger26c	16.41
ger21c ger27c	6.20
ger21c ger28c	25.56
ger21c ger29c	8.50
ger21c ger30c	5.86
ger22c ger26c	2.38
ger22c ger27c	7.55
ger22c ger28c	12.19
ger22c ger29c	21.69
ger22c ger30c	8.56
ger23c ger26c	8.31
ger23c ger27c	0.09
ger23c ger28c	17.44
ger23c ger29c	16.23
ger23c ger30c	1.34

ger24c	ger26c	2.86
ger24c	ger27c	8.22
ger24c	ger28c	12.69
ger24c	ger29c	21.03
ger24c	ger30c	8.77
ger25c	ger26c	0.62
ger25c	ger27c	11.30
ger25c	ger28c	9.64
ger25c	ger29c	24.39
ger25c	ger30c	11.06

RELATIVE CE 90% = 20.00

STATISTICS SUMMARY, TAPE ADRI01SP8MM00011 VERTICAL ANALYSIS
ALL VALUES IN METERS

ABSOLUTE VERTICAL ACCURACY

POINT ID	DELTA HEIGHT
ger1c	-42.70
ger2c	-46.76
ger3c	-39.84
ger4c	-37.52
ger5c	-41.42
ger6c	-8.28
ger7c	-31.73
ger8c	-36.25
ger9c	-20.33
ger10c	-45.69
ger11c	-39.11
ger12c	-40.90
ger13c	-45.50
ger14c	-46.96
ger15c	-35.90
ger16c	-53.86
ger17c	-51.35
ger18c	-81.85
ger19c	-116.95
ger20c	-50.70
ger21c	-32.35
ger22c	-54.75
ger23c	-42.45
ger24c	-29.35
ger25c	-40.85
ger26c	-45.87
ger27c	-50.88
ger28c	-22.19
ger29c	-33.72
ger30c	-55.65

NUMBER OF POINTS = 30

90% LINEAR ERROR =	68.37
MEAN	-44.06
SIGMA	18.97
RMS	47.84
AVERAGE ERROR	44.06

VERTICAL RELATIVE ACCURACY

TOTAL NUMBER OF POINT PAIR COMBINATIONS = 435

LOW BIN: ALL POINTS LESS THAN 60 KM APART

ID POINT COMBINATION	DELTA HEIGHT
ger1c ger2c	4.06
ger1c ger3c	2.86
ger1c ger4c	5.18
ger1c ger5c	1.28
ger2c ger4c	9.24
ger2c ger5c	5.34
ger3c ger5c	1.58
ger4c ger5c	3.90
ger6c ger10c	37.41
ger7c ger8c	4.52
ger7c ger9c	11.40
ger8c ger9c	15.92
ger11c ger12c	1.79
ger11c ger13c	6.39
ger11c ger14c	7.85
ger11c ger15c	3.21
ger11c ger23c	3.34
ger12c ger13c	4.60
ger12c ger14c	6.06
ger12c ger15c	5.00
ger13c ger14c	1.46
ger14c ger15c	11.06
ger15c ger23c	6.55
ger16c ger17c	2.51
ger16c ger18c	27.99
ger16c ger19c	63.09
ger16c ger20c	3.16
ger17c ger20c	0.65
ger18c ger20c	31.15
ger19c ger20c	66.25
ger21c ger22c	22.40
ger21c ger23c	10.10
ger21c ger24c	3.00
ger21c ger25c	8.50
ger22c ger23c	12.30
ger22c ger24c	25.40
ger22c ger25c	13.90
ger23c ger24c	13.10
ger23c ger25c	1.60
ger24c ger25c	11.50
ger26c ger27c	5.02
ger26c ger28c	23.68
ger26c ger29c	12.14
ger26c ger30c	9.78
ger27c ger28c	28.69
ger27c ger29c	17.16
ger27c ger30c	4.76
ger28c ger29c	11.53
ger28c ger30c	33.46
ger29c ger30c	21.92

RELATIVE LE 90% = 31.15

HIGH BIN: ALL POINTS GREATER THAN 60 KM APART

ID POINT COMBINATION	DELTA HEIGHT
ger1c ger6c	34.42
ger1c ger7c	10.97
ger1c ger8c	6.45
ger1c ger9c	22.37
ger1c ger10c	2.99
ger1c ger11c	3.59
ger1c ger12c	1.80
ger1c ger13c	2.80
ger1c ger14c	4.26
ger1c ger15c	6.80
ger1c ger16c	11.16
ger1c ger17c	8.65
ger1c ger18c	39.15
ger1c ger19c	74.25
ger1c ger20c	8.00
ger1c ger21c	10.35
ger1c ger22c	12.05
ger1c ger23c	0.25
ger1c ger24c	13.35
ger1c ger25c	1.85
ger1c ger26c	3.17
ger1c ger27c	8.18
ger1c ger28c	20.51
ger1c ger29c	8.98
ger1c ger30c	12.95
ger2c ger3c	6.92
ger2c ger6c	38.47
ger2c ger7c	15.03
ger2c ger8c	10.51
ger2c ger9c	26.42
ger2c ger10c	1.07
ger2c ger11c	7.65
ger2c ger12c	5.86
ger2c ger13c	1.26
ger2c ger14c	0.20
ger2c ger15c	10.86
ger2c ger16c	7.10
ger2c ger17c	4.59
ger2c ger18c	35.09
ger2c ger19c	70.19
ger2c ger20c	3.94
ger2c ger21c	14.41
ger2c ger22c	7.99
ger2c ger23c	4.31
ger2c ger24c	17.41
ger2c ger25c	5.91
ger2c ger26c	0.89
ger2c ger27c	4.13
ger2c ger28c	24.57
ger2c ger29c	13.04
ger2c ger30c	8.89

ger3c ger4c	2.32
ger3c ger6c	31.56
ger3c ger7c	8.11
ger3c ger8c	3.59
ger3c ger9c	19.51
ger3c ger10c	5.85
ger3c ger11c	0.73
ger3c ger12c	1.06
ger3c ger13c	5.66
ger3c ger14c	7.12
ger3c ger15c	3.94
ger3c ger16c	14.02
ger3c ger17c	11.51
ger3c ger18c	42.01
ger3c ger19c	77.11
ger3c ger20c	10.86
ger3c ger21c	7.49
ger3c ger22c	14.91
ger3c ger23c	2.61
ger3c ger24c	10.49
ger3c ger25c	1.01
ger3c ger26c	6.02
ger3c ger27c	11.04
ger3c ger28c	17.65
ger3c ger29c	6.12
ger3c ger30c	15.80
ger4c ger6c	29.24
ger4c ger7c	5.79
ger4c ger8c	1.27
ger4c ger9c	17.19
ger4c ger10c	8.17
ger4c ger11c	1.59
ger4c ger12c	3.38
ger4c ger13c	7.98
ger4c ger14c	9.44
ger4c ger15c	1.62
ger4c ger16c	16.34
ger4c ger17c	13.83
ger4c ger18c	44.33
ger4c ger19c	79.43
ger4c ger20c	13.18
ger4c ger21c	5.17
ger4c ger22c	17.23
ger4c ger23c	4.93
ger4c ger24c	8.17
ger4c ger25c	3.33
ger4c ger26c	8.35
ger4c ger27c	13.37
ger4c ger28c	15.33
ger4c ger29c	3.80
ger4c ger30c	18.13
ger5c ger6c	33.13
ger5c ger7c	9.69
ger5c ger8c	5.17

ger5c ger9c	21.08
ger5c ger10c	4.27
ger5c ger11c	2.31
ger5c ger12c	0.52
ger5c ger13c	4.08
ger5c ger14c	5.55
ger5c ger15c	5.52
ger5c ger16c	12.45
ger5c ger17c	9.93
ger5c ger18c	40.43
ger5c ger19c	75.53
ger5c ger20c	9.28
ger5c ger21c	9.07
ger5c ger22c	13.33
ger5c ger23c	1.03
ger5c ger24c	12.07
ger5c ger25c	0.57
ger5c ger26c	4.45
ger5c ger27c	9.47
ger5c ger28c	19.23
ger5c ger29c	7.70
ger5c ger30c	14.23
ger6c ger7c	23.45
ger6c ger8c	27.97
ger6c ger9c	12.05
ger6c ger11c	30.83
ger6c ger12c	32.62
ger6c ger13c	37.22
ger6c ger14c	38.68
ger6c ger15c	27.62
ger6c ger16c	45.58
ger6c ger17c	43.07
ger6c ger18c	73.57
ger6c ger19c	108.67
ger6c ger20c	42.42
ger6c ger21c	24.07
ger6c ger22c	46.47
ger6c ger23c	34.17
ger6c ger24c	21.07
ger6c ger25c	32.57
ger6c ger26c	37.58
ger6c ger27c	42.60
ger6c ger28c	13.91
ger6c ger29c	25.44
ger6c ger30c	47.36
ger7c ger10c	13.96
ger7c ger11c	7.38
ger7c ger12c	9.17
ger7c ger13c	13.77
ger7c ger14c	15.23
ger7c ger15c	4.17
ger7c ger16c	22.13
ger7c ger17c	19.62
ger7c ger18c	50.12

ger7c ger19c	85.22
ger7c ger20c	18.97
ger7c ger21c	0.62
ger7c ger22c	23.02
ger7c ger23c	10.72
ger7c ger24c	2.38
ger7c ger25c	9.12
ger7c ger26c	14.14
ger7c ger27c	19.15
ger7c ger28c	9.54
ger7c ger29c	1.99
ger7c ger30c	23.92
ger8c ger10c	9.44
ger8c ger11c	2.86
ger8c ger12c	4.65
ger8c ger13c	9.25
ger8c ger14c	10.71
ger8c ger15c	0.35
ger8c ger16c	17.61
ger8c ger17c	15.10
ger8c ger18c	45.60
ger8c ger19c	80.70
ger8c ger20c	14.45
ger8c ger21c	3.90
ger8c ger22c	18.50
ger8c ger23c	6.20
ger8c ger24c	6.90
ger8c ger25c	4.60
ger8c ger26c	9.62
ger8c ger27c	14.63
ger8c ger28c	14.06
ger8c ger29c	2.53
ger8c ger30c	19.40
ger9c ger10c	25.36
ger9c ger11c	18.78
ger9c ger12c	20.57
ger9c ger13c	25.17
ger9c ger14c	26.63
ger9c ger15c	15.57
ger9c ger16c	33.53
ger9c ger17c	31.02
ger9c ger18c	61.52
ger9c ger19c	96.62
ger9c ger20c	30.37
ger9c ger21c	12.02
ger9c ger22c	34.42
ger9c ger23c	22.12
ger9c ger24c	9.02
ger9c ger25c	20.52
ger9c ger26c	25.53
ger9c ger27c	30.55
ger9c ger28c	1.86
ger9c ger29c	13.39
ger9c ger30c	35.31

ger10c ger11c	6.58
ger10c ger12c	4.79
ger10c ger13c	0.19
ger10c ger14c	1.27
ger10c ger15c	9.79
ger10c ger16c	8.17
ger10c ger17c	5.66
ger10c ger18c	36.16
ger10c ger19c	71.26
ger10c ger20c	5.01
ger10c ger21c	13.34
ger10c ger22c	9.06
ger10c ger23c	3.24
ger10c ger24c	16.34
ger10c ger25c	4.84
ger10c ger26c	0.17
ger10c ger27c	5.19
ger10c ger28c	23.50
ger10c ger29c	11.97
ger10c ger30c	9.96
ger11c ger16c	14.75
ger11c ger17c	12.24
ger11c ger18c	42.74
ger11c ger19c	77.84
ger11c ger20c	11.59
ger11c ger21c	6.76
ger11c ger22c	15.64
ger11c ger24c	9.76
ger11c ger25c	1.74
ger11c ger26c	6.76
ger11c ger27c	11.77
ger11c ger28c	16.92
ger11c ger29c	5.39
ger11c ger30c	16.54
ger12c ger16c	12.96
ger12c ger17c	10.45
ger12c ger18c	40.95
ger12c ger19c	76.05
ger12c ger20c	9.80
ger12c ger21c	8.55
ger12c ger22c	13.85
ger12c ger23c	1.55
ger12c ger24c	11.55
ger12c ger25c	0.05
ger12c ger26c	4.97
ger12c ger27c	9.98
ger12c ger28c	18.71
ger12c ger29c	7.18
ger12c ger30c	14.75
ger13c ger15c	9.60
ger13c ger16c	8.36
ger13c ger17c	5.85
ger13c ger18c	36.35
ger13c ger19c	71.45

ger13c	ger20c	5.20
ger13c	ger21c	13.15
ger13c	ger22c	9.25
ger13c	ger23c	3.05
ger13c	ger24c	16.15
ger13c	ger25c	4.65
ger13c	ger26c	0.37
ger13c	ger27c	5.38
ger13c	ger28c	23.31
ger13c	ger29c	11.78
ger13c	ger30c	10.15
ger14c	ger16c	6.90
ger14c	ger17c	4.39
ger14c	ger18c	34.89
ger14c	ger19c	69.99
ger14c	ger20c	3.74
ger14c	ger21c	14.61
ger14c	ger22c	7.79
ger14c	ger23c	4.51
ger14c	ger24c	17.61
ger14c	ger25c	6.11
ger14c	ger26c	1.10
ger14c	ger27c	3.92
ger14c	ger28c	24.77
ger14c	ger29c	13.24
ger14c	ger30c	8.68
ger15c	ger16c	17.96
ger15c	ger17c	15.45
ger15c	ger18c	45.95
ger15c	ger19c	81.05
ger15c	ger20c	14.80
ger15c	ger21c	3.55
ger15c	ger22c	18.85
ger15c	ger24c	6.55
ger15c	ger25c	4.95
ger15c	ger26c	9.97
ger15c	ger27c	14.98
ger15c	ger28c	13.71
ger15c	ger29c	2.18
ger15c	ger30c	19.75
ger16c	ger21c	21.51
ger16c	ger22c	0.89
ger16c	ger23c	11.41
ger16c	ger24c	24.51
ger16c	ger25c	13.01
ger16c	ger26c	8.00
ger16c	ger27c	2.98
ger16c	ger28c	31.67
ger16c	ger29c	20.14
ger16c	ger30c	1.78
ger17c	ger18c	30.50
ger17c	ger19c	65.60
ger17c	ger21c	19.00
ger17c	ger22c	3.40

ger17c ger23c	8.90
ger17c ger24c	22.00
ger17c ger25c	10.50
ger17c ger26c	5.48
ger17c ger27c	0.47
ger17c ger28c	29.16
ger17c ger29c	17.63
ger17c ger30c	4.30
ger18c ger19c	35.10
ger18c ger21c	49.50
ger18c ger22c	27.10
ger18c ger23c	39.40
ger18c ger24c	52.50
ger18c ger25c	41.00
ger18c ger26c	35.98
ger18c ger27c	30.97
ger18c ger28c	59.66
ger18c ger29c	48.13
ger18c ger30c	26.20
ger19c ger21c	84.60
ger19c ger22c	62.20
ger19c ger23c	74.50
ger19c ger24c	87.60
ger19c ger25c	76.10
ger19c ger26c	71.08
ger19c ger27c	66.07
ger19c ger28c	94.76
ger19c ger29c	83.23
ger19c ger30c	61.30
ger20c ger21c	18.35
ger20c ger22c	4.05
ger20c ger23c	8.25
ger20c ger24c	21.35
ger20c ger25c	9.85
ger20c ger26c	4.83
ger20c ger27c	0.18
ger20c ger28c	28.51
ger20c ger29c	16.98
ger20c ger30c	4.95
ger21c ger26c	13.52
ger21c ger27c	18.53
ger21c ger28c	10.16
ger21c ger29c	1.37
ger21c ger30c	23.30
ger22c ger26c	8.88
ger22c ger27c	3.87
ger22c ger28c	32.56
ger22c ger29c	21.03
ger22c ger30c	0.90
ger23c ger26c	3.42
ger23c ger27c	8.43
ger23c ger28c	20.26
ger23c ger29c	8.73
ger23c ger30c	13.20

ger24c	ger26c	16.52
ger24c	ger27c	21.53
ger24c	ger28c	7.16
ger24c	ger29c	4.37
ger24c	ger30c	26.30
ger25c	ger26c	5.02
ger25c	ger27c	10.03
ger25c	ger28c	18.66
ger25c	ger29c	7.13
ger25c	ger30c	14.80

RELATIVE LE 90% = 45.58

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